MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EEL3156 RENEWABLE ENERGY TECHNOLOGY

(All Sections / Groups)

12 MARCH 2020
09:00 A.M – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 pages including this cover page with 5 questions only.

2. Attempt all 5 questions. All questions carry equal marks and the distribution of marks for each question is given.

3. Please print all your answers in the answer booklet provided.

Question 1

(a) Briefly discuss the motivations of renewable energy.

[2 marks]

(b) Draw a diagram showing the essential components of a typical hydroelectric power plant.

[8 marks]

(c) Discuss the challenges (weaknesses) of hydropower.

[4 marks]

(d) Discuss the benefits of wind power.

[3 marks]

(e) Discuss the challenges (weaknesses) of wind power.

[3 marks]

Question 2

(a) Identify FOUR forms of renewable energy which are derived from the Sun. Briefly explain how each of the aforementioned form of renewable energy is derived.

[12 marks]

(b) Explain how biogas is being produced and utilised to produce electrical power.

[4 marks]

(c) Sustainability can be defined as the conduct of human activity in a manner which meets the needs of the present without jeopardising the ability of future generations to meet their needs. Discuss how geothermal energy relates to sustainability.

[4 marks]

Continued ...

Question 3

(a) A hydropower plant has the following specifications:

Available water head:	81 m
Number of turbines:	32 (each is paired with one generator)
Flow rate per turbine:	950 m^3/s
Turbine rotational speed:	75 rpm
Turbine efficiency:	95%
Generator efficiency:	95%
Annual generation:	100 TWh
Water density:	997 kg/m^3
Gravity acceleration:	9.81 m/s^2

Determine the following:

(i) The output mechanical power per turbine.
[3 marks]

(ii) The output electrical power per generator.
[1 mark]

(iii) The installed capacity.
[1 mark]

(iv) The capacity factor.
[1 mark]

(v) The turbines' non-dimensional shape number.
[4 marks]

(b) A horizontal axis 3-bladed wind turbine has optimal power coefficient $C_p = 45\%$ at tip-speed-ratio $\lambda = 6$. The blade length is 50 m. The air density is 1.2 kg/m^3. Determine the following for a wind speed of 12 m/s at optimal operating condition:

(i) The turbine's output power.
[4 marks]

(ii) The turbine's rotational speed.
[3 marks]

(iii) The turbine's axial trust.
[3 marks]

Continued ...

Question 4

(a) A solar photovoltaic system has the characteristics as shown in Table 4-1.

Table 4-1

Parameter	Value
Solar irradiation (kWh/m^2)	2000
DC power output (kWp)	15
Module mismatch of power (k_{mm})	0.98
Soiling (k_{dirt})	0.93
Cell temperature (k_{temp})	0.97
Cable loss	5%
Shading (k_{shade})	0.96
Inverter efficiency ($\eta_{inverter}$)	98.20%

Estimate the following:

(i) Total energy generated by the system. [8 marks]

(ii) Specific yield. [2 marks]

(iii) Performance ratio (%) [2 marks]

Continued ...

Question 4 (continued)

(b) The sizing of an anaerobic digester is crucial for the production of biogas. Table 4-2 shows the typical manure output from farm animals. Given that the density of dry matter in the fluid of the digester is 50 kg/m^3, the heat of combustion per unit volume biogas is 20 MJ/m^3 and the biogas yield per unit dry mass of whole input is 0.3 m^3/kg, calculate the following:

(i) The volume of a biogas digester suitable for the output of 6000 goats.
[4 marks]

(ii) The energy output of the digester, assuming a retention time of 15 days and a burner efficiency of 0.6.
[4 marks]

Table 4-2

Animal	Total wet manure per animal per day (kg)	Of which, total solids (kg)	Moisture mass content/wet mass
Dairy Cow (≈500kg)	35	4.5	87%
Goat (≈100kg)	4	0.5	90%
Laying hen	0.12	0.03	75%

Question 5

(a) Discuss the main challenge of integrating solar PV power into the utility grid A.
[10 marks]

(b) Electrical energy storage system is a viable solution to the problems facing the power network, in particularly in meeting new and unpredictable demands of providing coherent electricity supply. State FIVE factors which determines the suitability of an electrical energy storage technology.
[5 marks]

(c) State FIVE types of energy storage system.
[5 marks]

End of Paper